Using Turbulence Auto-PIREP's to Improve Pilots' Turbulence Situational Awareness

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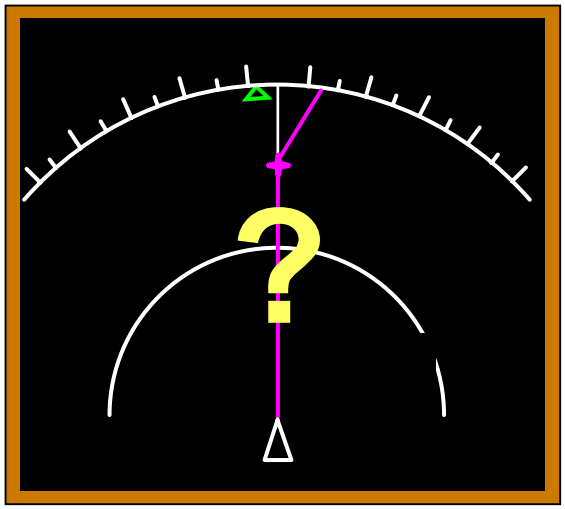
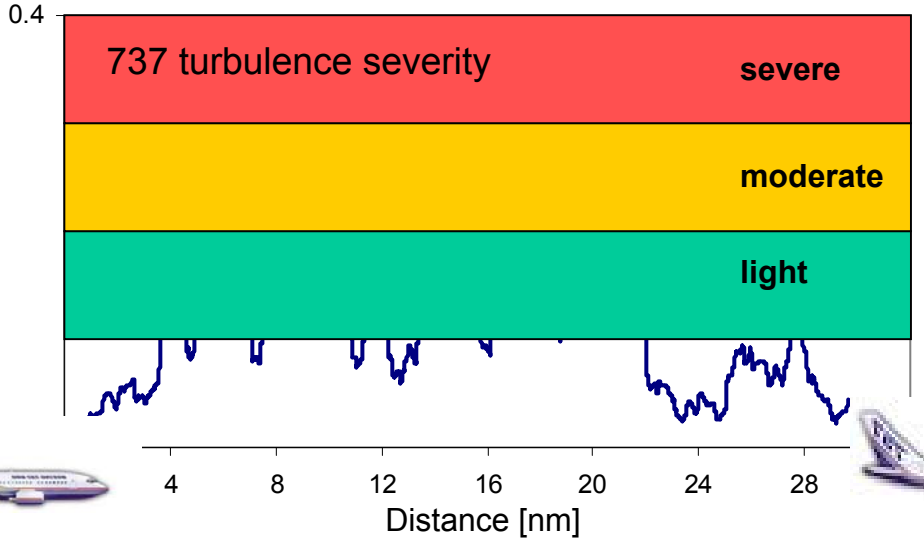
PAR

How to report the turbulence?





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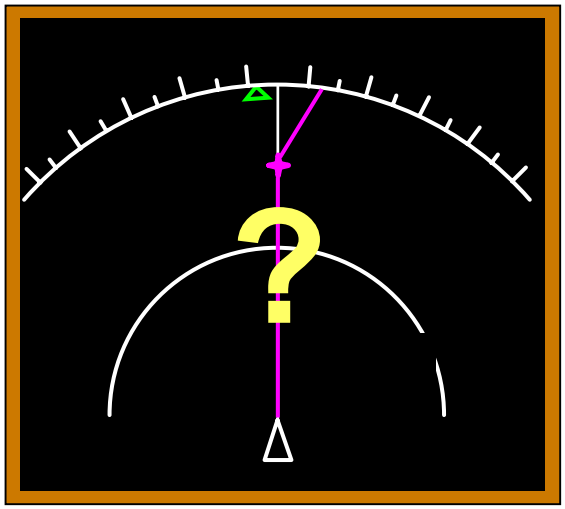

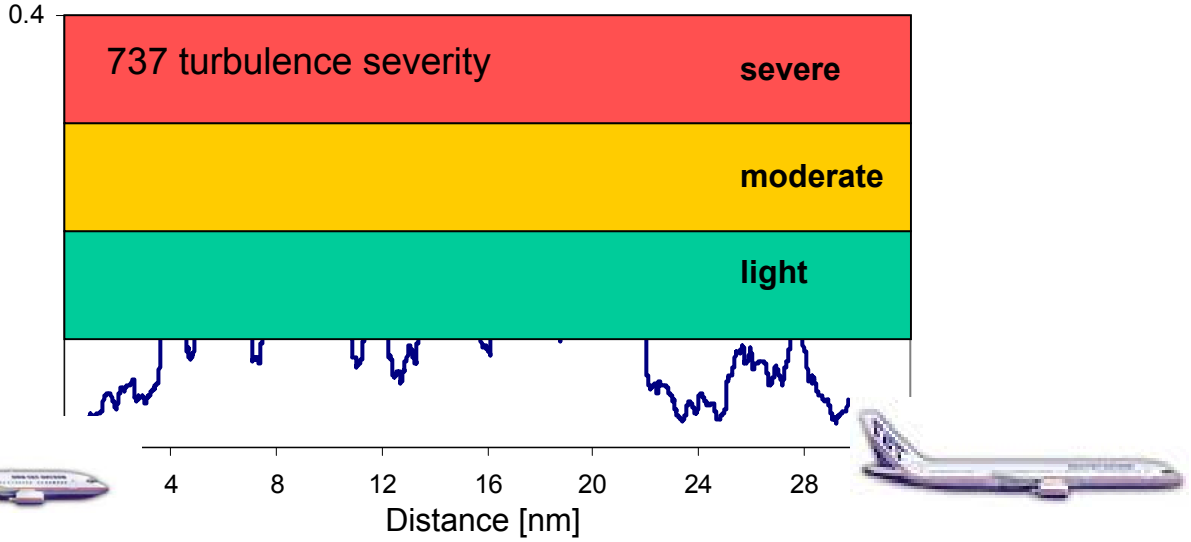

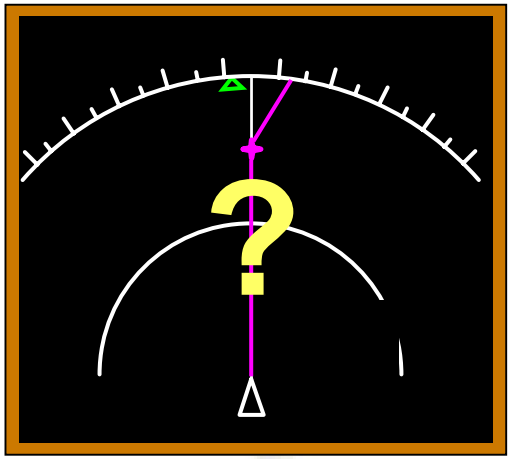

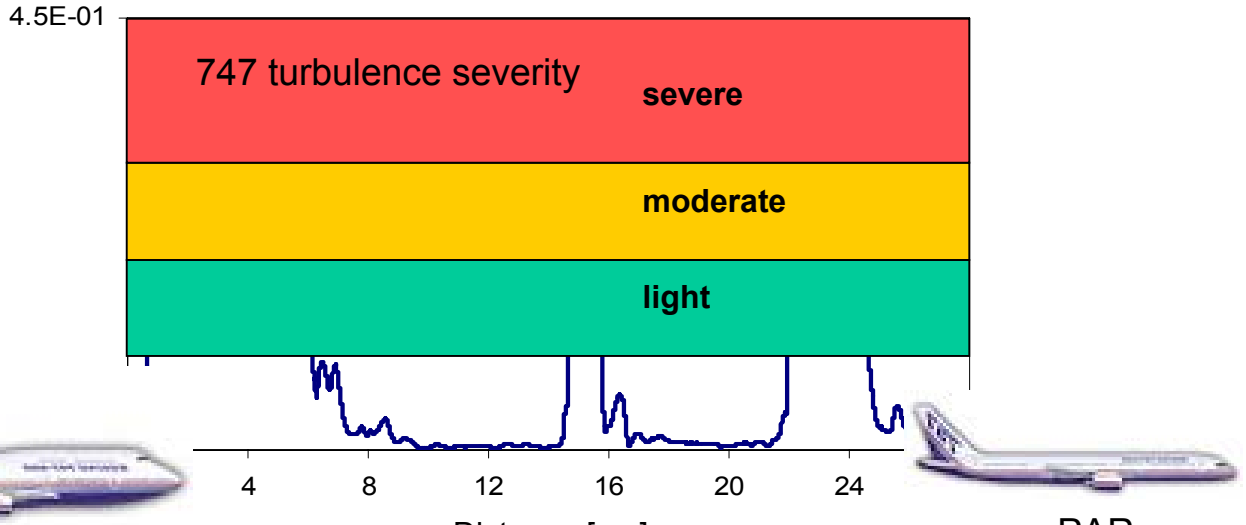

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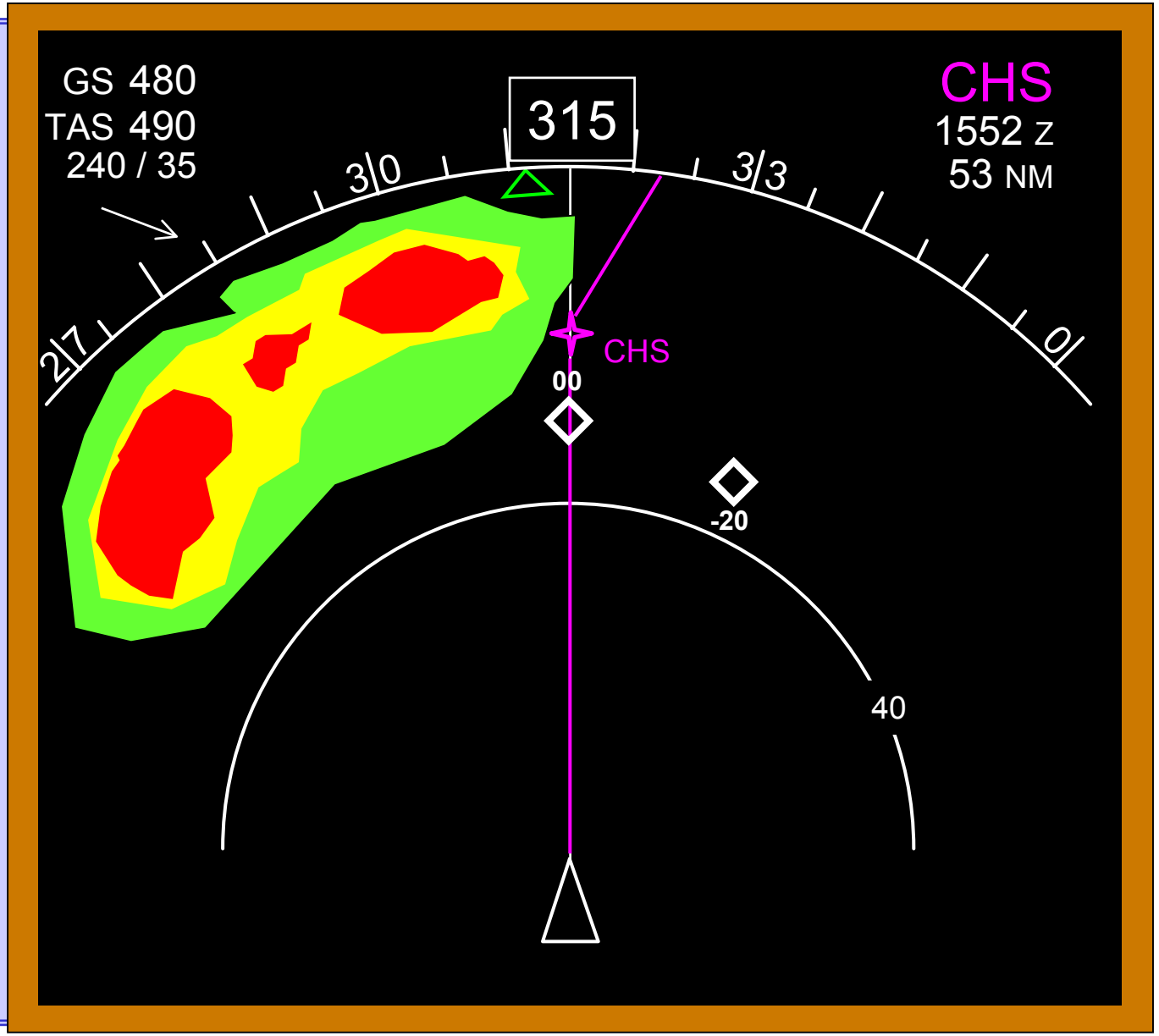
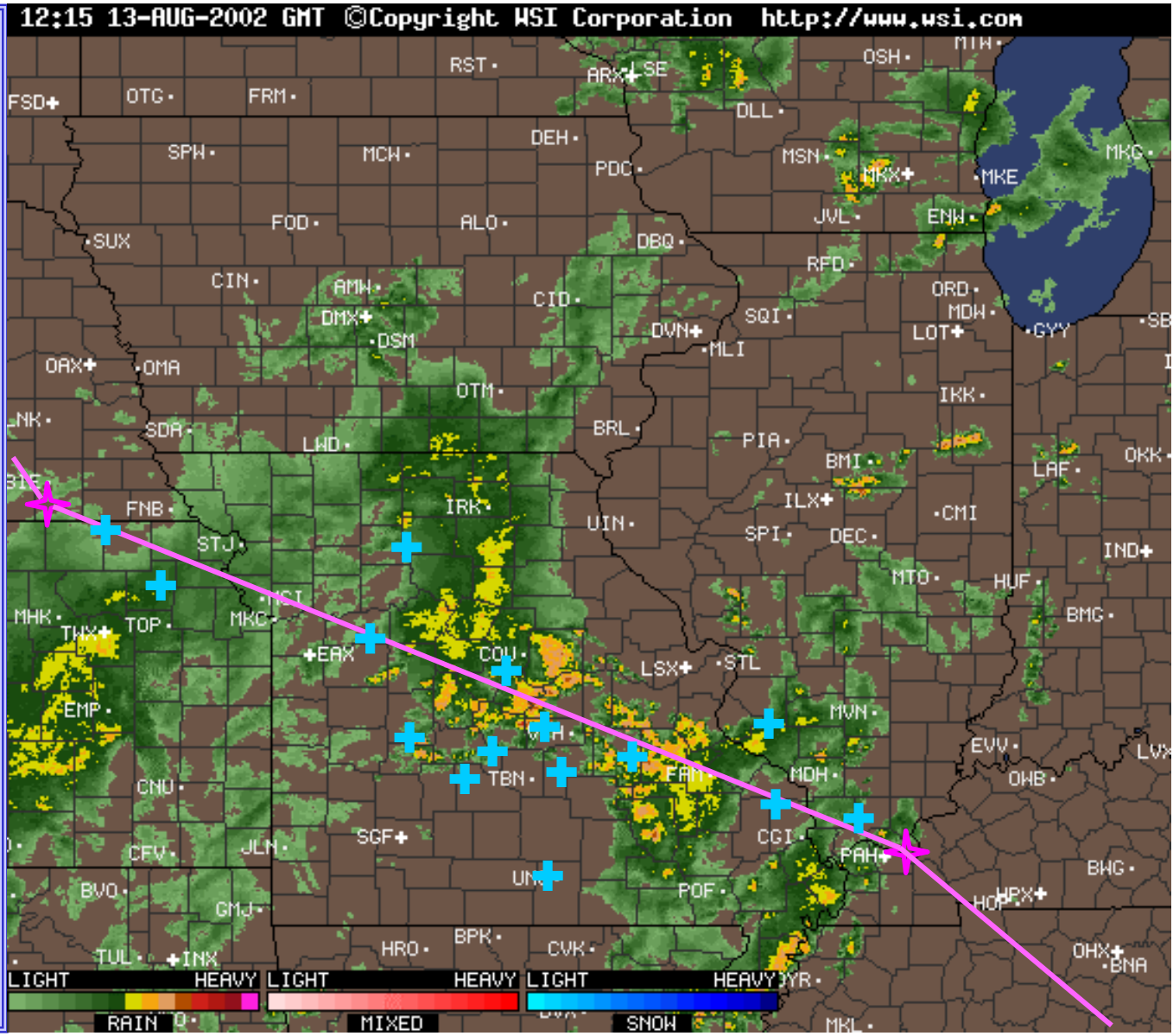
Example Operational Scenario Today: Near Convection

- Convection detected by onboard radar
- Other aircraft in general vicinity
- Turbulence reports received (voice)
- Turbulence awareness from PIREPS, ATC, AOC/dispatch
- *Situational awareness of turbulence limited*



Example Scenario Today: Preflight Dispatch

- Region of convection affecting planned flight path (purple line).
- Other aircraft on and around flight path (blue crosses)
- PIREPS relayed to dispatch/AOC/OCC
- *Situational awareness of turbulence limited*



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Turbulence Auto-PIREP's System

Goal is to develop technology that :

- removes subjectivity, inaccuracies, and latencies in current turbulence PIREP's
- no additional pilot workload
- increases flight crew situational awareness of turbulence
- is advisory in nature
- uses ***current system infrastructure - displays, comms, data***
- displays turbulence severity and location to flight-crew in real time with no inference required by the flight crew

Turbulence Auto-PIREP's System

To present to pilots, in real-time, reports of turbulence hazard location and severity scaled to receiving aircraft

End Users:

- ✓ Primary - flight crews (preflight & en route products)
- ✓ Secondary – AOC, dispatch, met.

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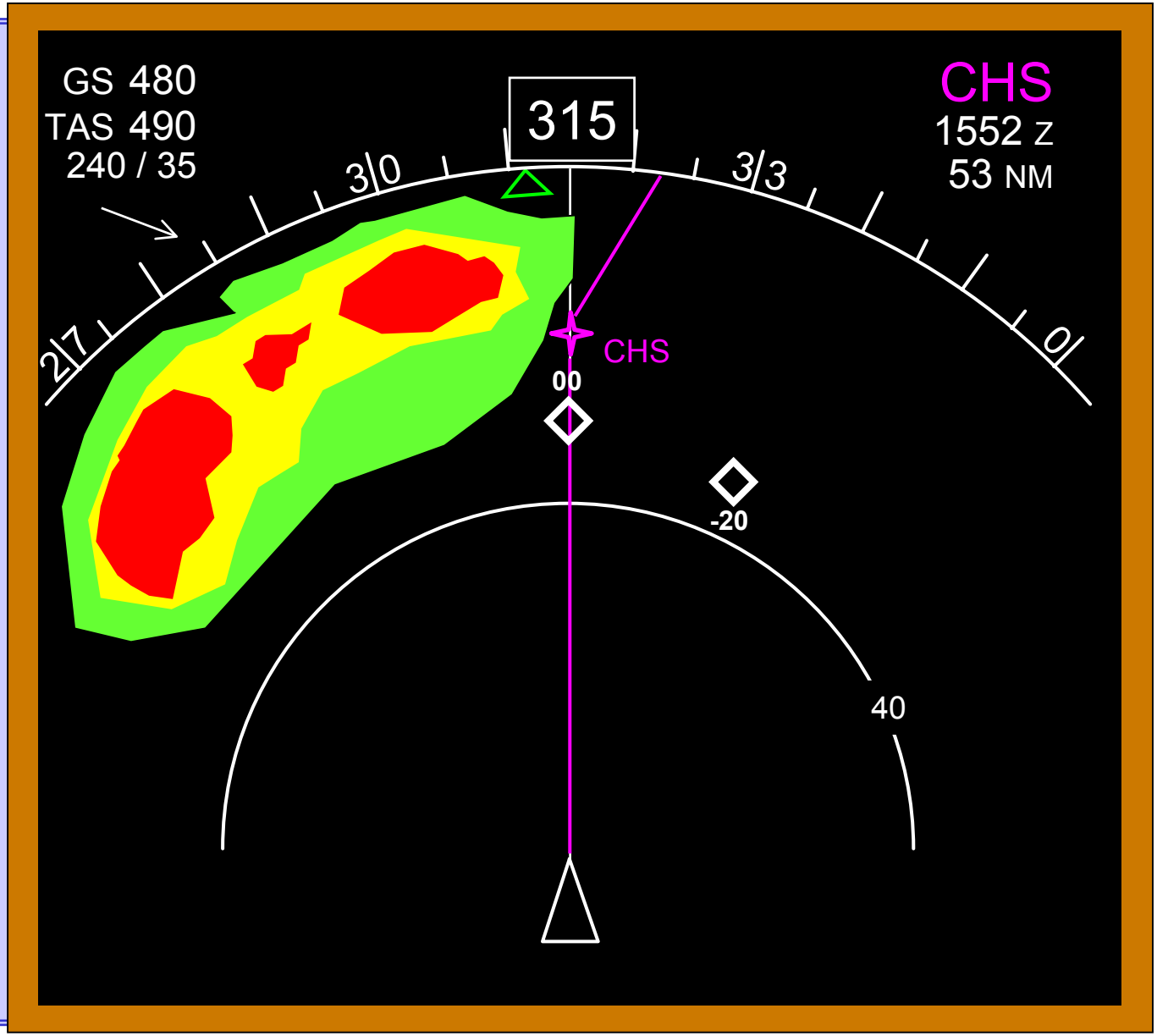
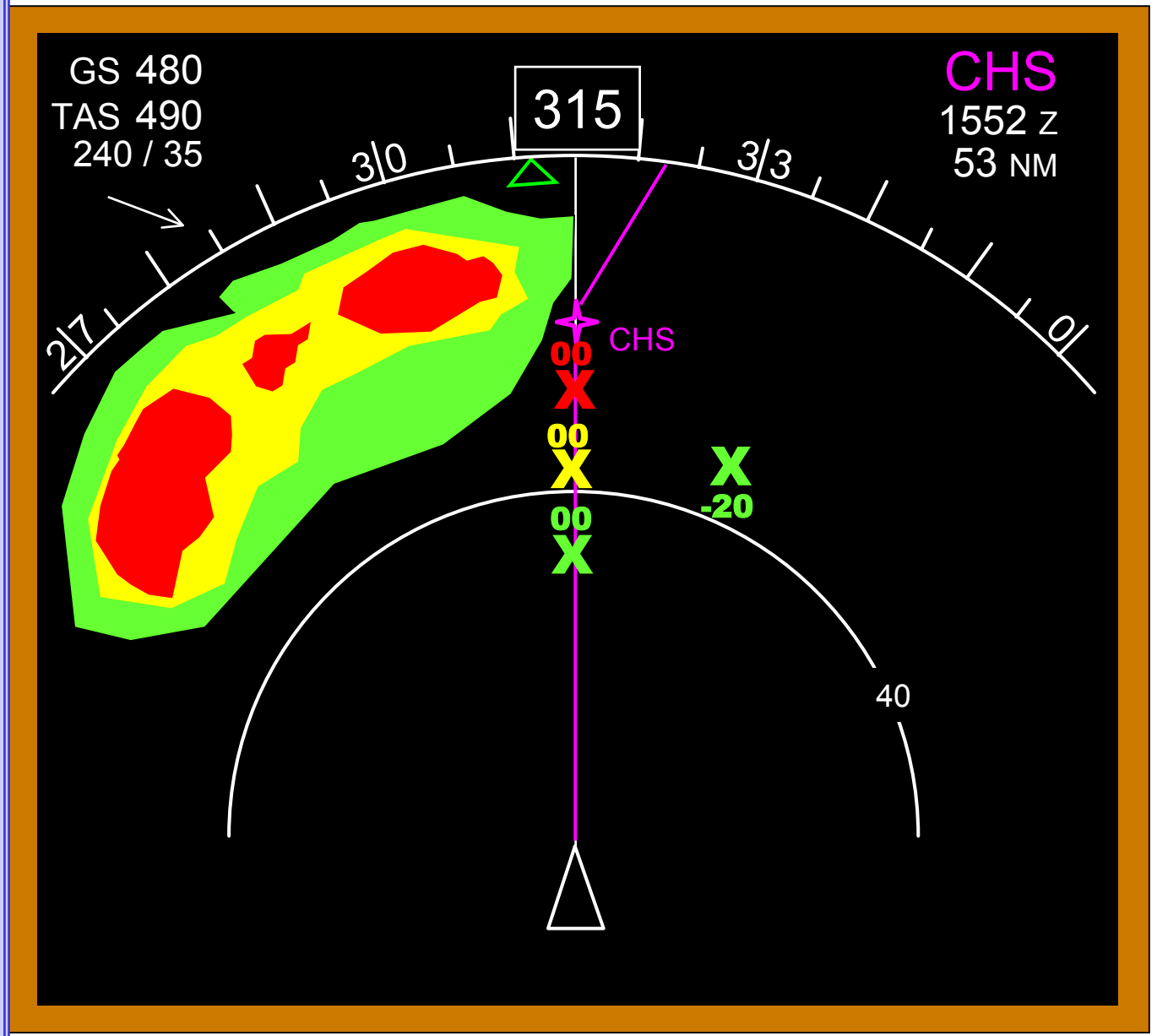


Example Scenario and Display Concept

- Operation in region of convection.
- Data received from other aircraft is translated into a turbulence hazard for the receiving aircraft.
- Same aircraft may transmit several warnings if severity increases. No transmission if no hazard.
- Hazard warning icons color-coded severe moderate light shown with relative altitude (100's of feet).
- In scenario shown, region of increasing turbulence severity ahead of aircraft; lighter turbulence seen from icon to right of track.
- Provides improved situational awareness of turbulence with no additional workload to pilot.



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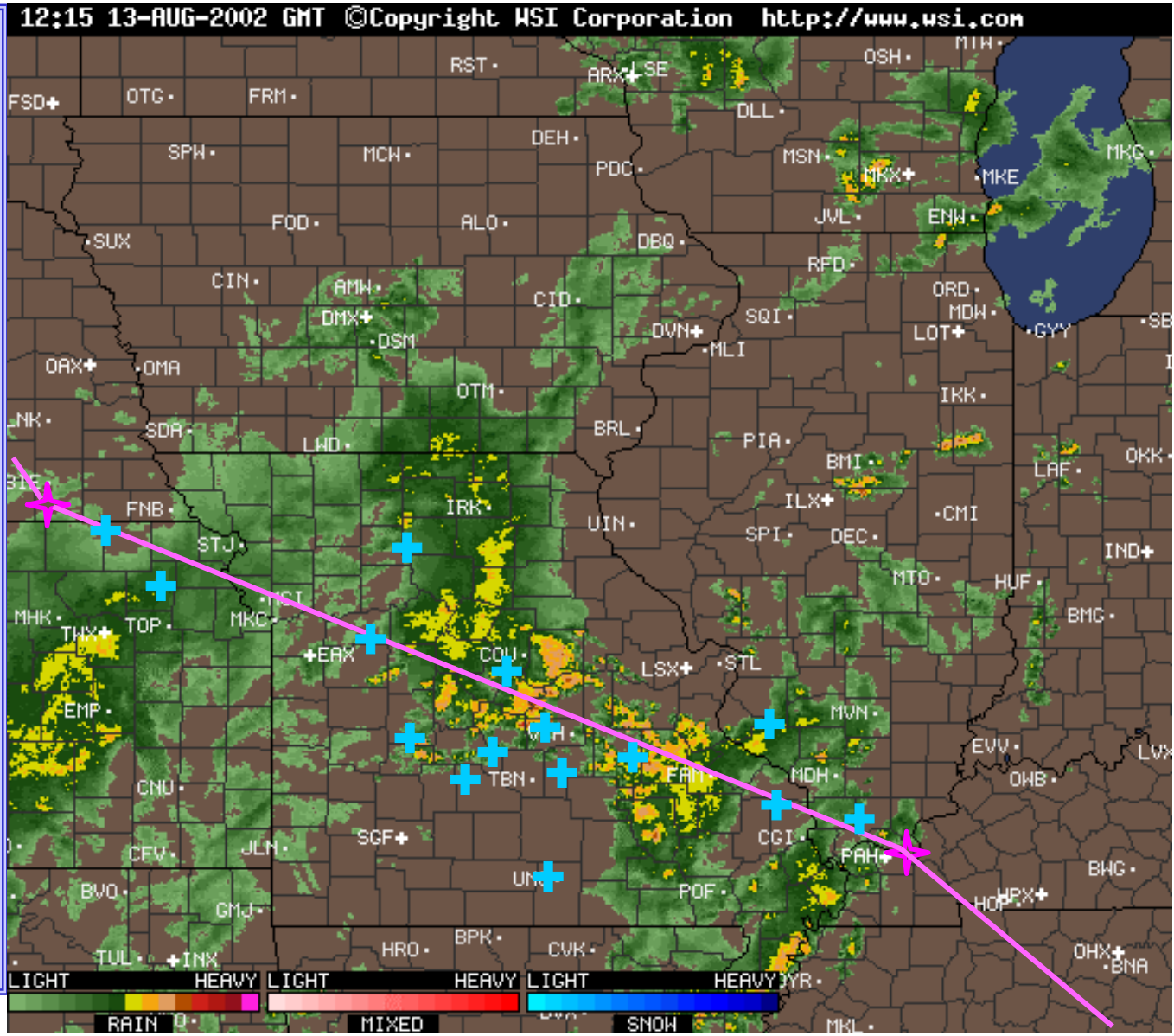
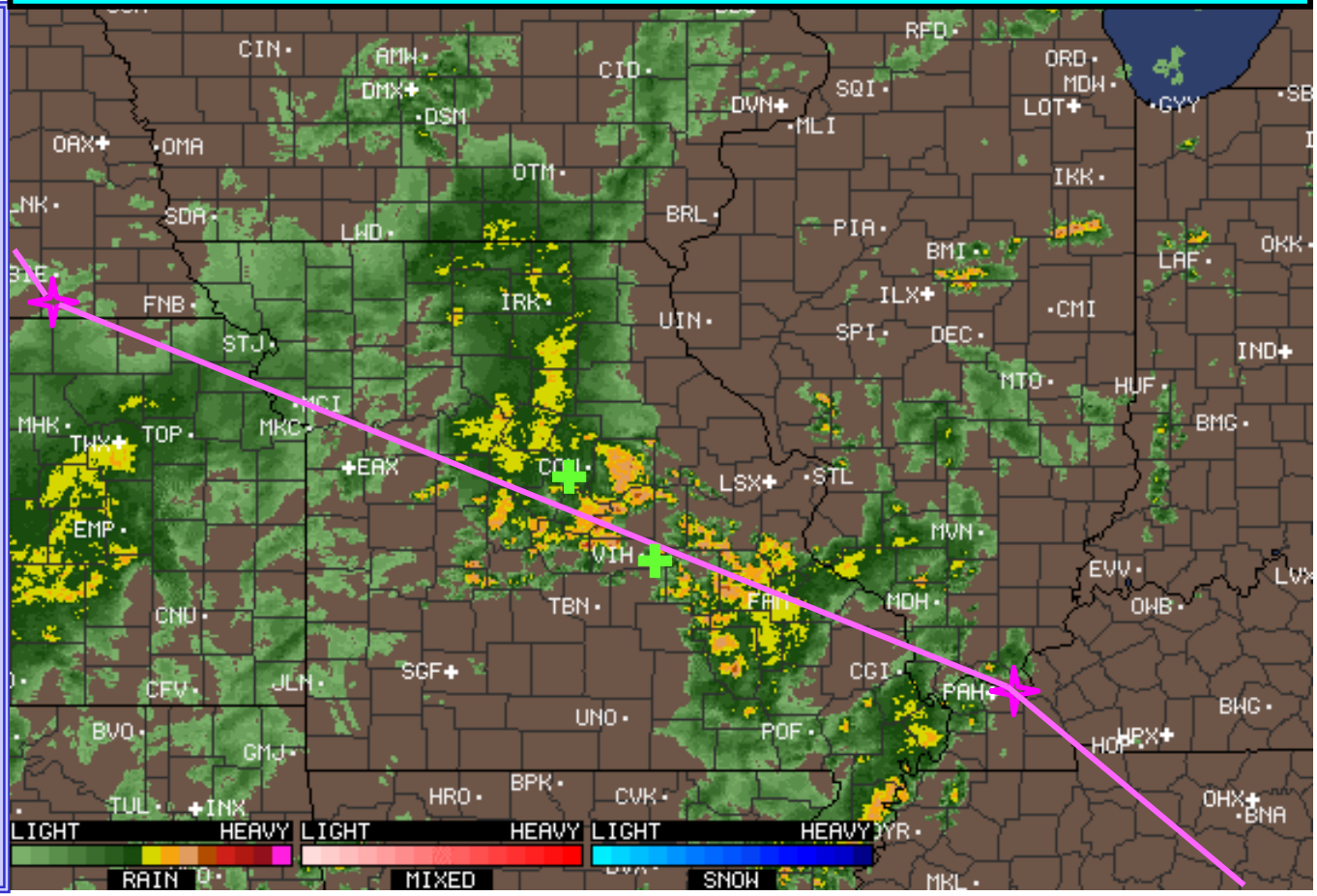


Example Concept Scenario: Preflight Dispatch

Type: B 777-200
Weight: 575,000 – 600,000 lbs
Alt: FL 310
Speed: M 0.82

- Region of convection affecting planned flight path (purple line).
- Specific aircraft type, weight, speed, and altitude
- Automated reports from other aircraft scaled to designated aircraft.
- *Situational awareness of turbulence improved*



Example Concept Scenario: Preflight Dispatch

Type: B 737-800
Weight: 130,000 – 150,000 lbs
Alt: FL 260
Speed: M 0.76

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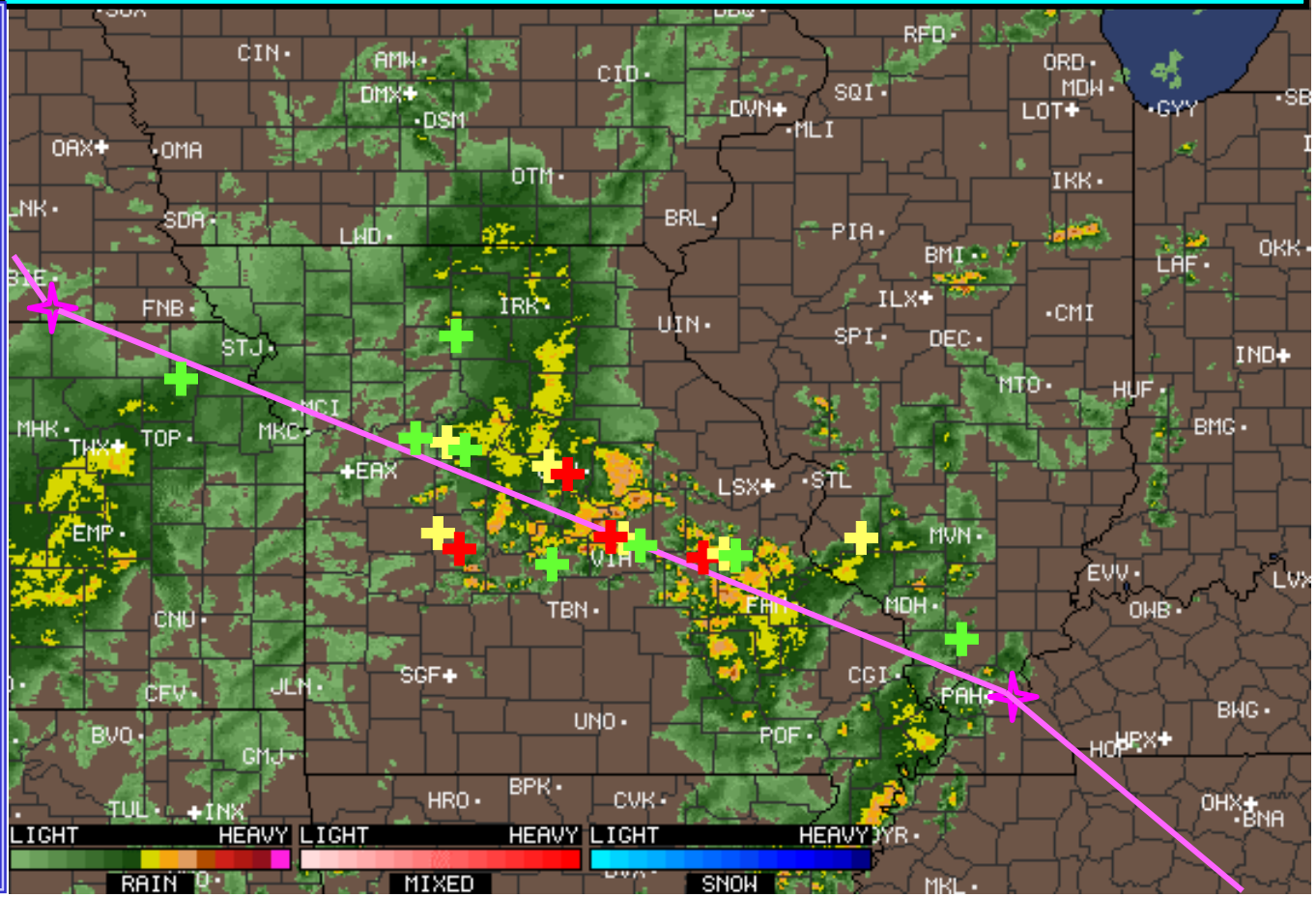

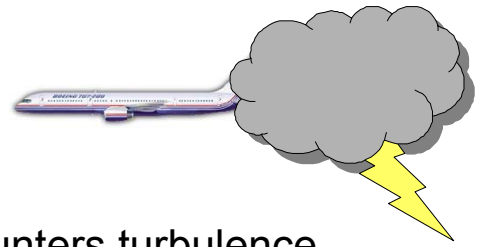

1. Aircraft encounters turbulence.
2. If loads are above a threshold then algorithm generates and broadcasts an alert packet.

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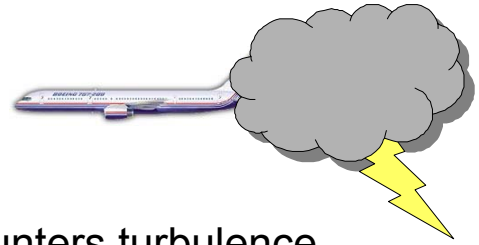

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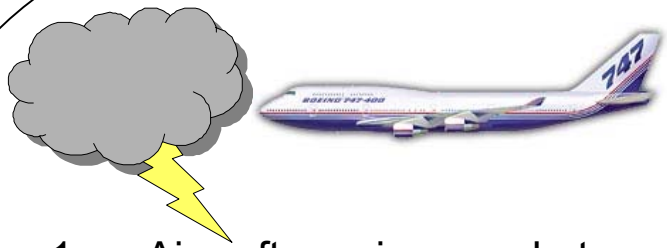
communications infrastructure



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2. Scales hazard to type & configuration.
3. Displays to flight crew (if at or above threshold).

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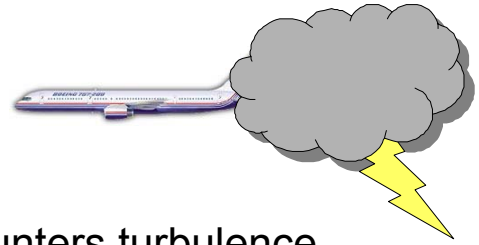

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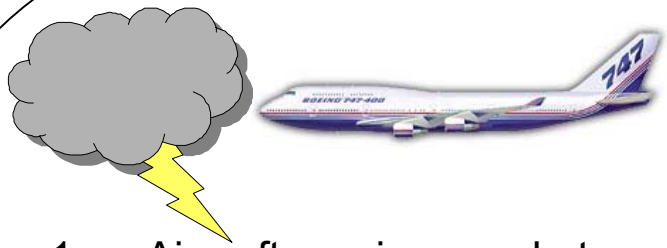

1. Aircraft receives packet.
2. Scales hazard to type & configuration.
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1. Packet received on ground & stored in database.
2. Presented on map, scaled to pilot's aircraft (if at or above threshold).

Work Status

- **Algorithms:**
  - » reporting – complete & expanding to other a/c types
  - » interpreting – complete & expanding to other types
  - » scaling – complete & expanding to other types
  - » displays – issues to be resolved
- **Flight testing**
  - » alerting logic and comms initial test complete
  - » multi-ship experiment needed (FY-03 plan)
- **System requirements definition**
  - » preliminary
  - » need FAA/industry collaboration
- **Government/Industry implementation group**
  - » Convened, Oct 8th, 2003

2002 Flight Experiment: Results

Goal:- *to test and evaluate preliminary alerting algorithm and communications capabilities*

- No missed transmissions
- Average round-trip latency in tx/rx – 0.52 sec.
- Alerts scaled with turbulence encounter severity
- Over 70 events and maneuvers acquired for algorithm refinement

FY-03 Planned Activities

Develop total system requirements.

- *user community participation*
- *implementation constraints*
- *integration with other systems*
- *flight crew simulations*

FY-03 Planned Activities

Develop total system requirements.

Develop operational concept simulations.

- *total system implementation*
- *assess operational effectiveness*

FY-03 Planned Activities

Develop total system requirements.

Develop operational concept simulations.

2-aircraft flight experiment.

- *Test system effectiveness in a real-time representative environment.*
- *Perform real-time & offline assessment of system effectiveness.*